OPTICAL RECORDING MEDIUM AND METHOD FOR FORMATTING

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to an optical recording medium and more particularly to a method of formatting a rewritable optical recording medium.

Discussion of Related Art

An optical storage medium is generally divided into a read only memory (ROM), a write once read many (WORM) memory into which data can be written one time, and rewritable memories into which data can be written several times. Rewritable optical storage mediums, i.e. optical discs, include rewritable compact discs (CD-R) and rewritable digital versatile discs (DVD-R, DVD-RAM, DVD+R).

The operations of writing and playing back data in a rewritable optical disc may be repeated. This repeated process alters the ratio of storage layers for recording data into the optical disc from the initial ratio. Thus, the optical discs lose its characteristics and generate an error during recording/playback. This degradation appears as a defective area at the time of formatting, recording on or playing back

from an optical storage medium. Also, defective areas of a rewritable optical disc may be caused by a scratch on its surface, particles of dirt and dust, or errors during manufacture. Therefore, in order to prevent writing into or reading out of the defective area, management of such defective areas is necessary.

FIG. 1 shows a defect management area (DMA) in a lead-in area and a lead-out area of the optical disc to manage a defect area. Particularly, the data area is divided into a plurality of zones for the defect area management, where each zone is further divided into a user area and a spare area. The user area is where data is actually written and the spare area is used when a defect occurs in the user area.

There are four DMAs in one disc, e.g. DVD-RAM, two of which exist in the lead-in area and two exist in the lead-out area. Because managing defective areas is important, the same contents are repeatedly recorded in all four DMAs to protect the data. Each DMA comprises two blocks of 32 sectors, where one block comprises 16 sectors. The first block of the DMA, called a DDS/PDL block, includes a disc definition structure (DDS) and a primary defect list (PDL). The second block of the DMA, called an SDL block, includes a secondary defect list (SDL). The PDL corresponds to a primary defect data storage

and the SDL corresponds to a secondary defect data storage.

The PDL generally stores entries of defective sectors caused during the manufacture of the disc or identified when formatting a disc, namely initializing and re-initializing a disc. Each entry is composed of an entry type and a sector number corresponding to a defective sector. The SDL lists defective areas in block units, thereby storing entries of defective blocks occurring after formatting or defective blocks which could not be stored in the PDL during the formatting. Each SDL entry has an area for storing a sector number of the first sector of a block having defective sectors, an area for storing a sector number of the first sector of a block replacing the defective block, and reserved areas. Accordingly, defective areas, i.e. defective sectors or defective blocks, within the data area are replaced with normal or non-defective sectors or blocks by a slipping replacement algorithm and a linear replacement algorithm.

The slipping replacement algorithm is utilized when a defective area is recorded in the PDL. As shown in FIG. 2A, if defective sectors m and n, corresponding to sectors in the user area, are recorded in the PDL, such defective sectors are skipped to the next available sector. By replacing the defective sectors by subsequent sectors, data is written to a

normal sector. As a result, the user area into which data is written slips and occupies the spare area in the amount equivalent to the skipped defective sectors. For example, if two defect sectors are registered in the PDL, data would occupy two sectors of the spare area.

The linear replacement algorithm is utilized when a defective block is recorded in the SDL or when a defective block is found during playback. As shown in FIG. 2B, if defective blocks m and n, corresponding to blocks in either the user or spare area, are recorded on the SDL, such defective blocks are replaced by normal blocks in the spare area and the data to be recorded in the defective block are recorded in an assigned spare area.

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As defective areas are compensated utilizing the spare area, methods of assigning the spare area plays an important role in the defective area management. Typically, the spare area may be allocated in each zone or group of the data area or may be allocated in a designated portion of the data area. One method is to allocate the spare area at the top of the data area, as shown in FIG. 3. In such case, the spare area is called a Primary Spare Area. Namely, the data area excluding the primary spare area becomes the user area.

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The primary spare area, assigned in an initial formatting

process, is assigned when a manufacturer produces the optical disc or when a user initially formats an empty disc. Moreover, when defect sectors are registered in the PDL according to the initial formatting or reformatting of optical disc, data cannot be recorded in those defect sectors, reducing the recording capacity. Therefore, to maintain the initial data recording capacity, a portion of the primary spare area equivalent to the defective sectors registered on the PDL slips into or becomes a part of the user area during formatting. Accordingly, the PSN of the user area to which a value of LSN=0 is assigned varies depending upon the defective sectors registered on the PDL.

If the primary spare area becomes full by slipping or linear replacement, as shown in FIG. 4A, a new spare area may be assigned, for example near the end of the user area. Such additional spare area is called a supplementary spare area (SA-sup). The location information of the supplementary spare area is stored in a specific area such as in the SDL block of the DMA. Particularly, the location information includes the start address (the first sector number) and the end address (the last sector number) of the assigned supplementary spare area. Thus, the size as well as the location of the supplementary spare area can be ascertained from the

information.

The assigned supplementary spare area may be enlarged when necessary as shown in FIG. 4B. Also, the location of the extended supplementary spare area is stored in the specific area of the DMA as in the initial assignment of the supplementary spare area. However, since a location information is already stored in the DMA, the start address of the location information is modified. As a result, the location information of the supplementary spare area is modified each time the supplementary spare area is enlarged.

Moreover, even in optical recording mediums with assigned supplementary spare area as described above, defect sectors or blocks are registered in the PDL or SDL for defect area management. Accordingly, linear replacement and slipping replacement is utilized. However, for linear replacement, the optical pick-up must be transferred to and back from the spare area to the user area in order to record data for the defect blocks registered in the SDL within the assigned replacement blocks. Repetition of this may deteriorate the system performance. As a result, the optical medium is reformatted to move the defect sectors registered in the SDL to the PDL, thereby reducing the number of linear replacements and improving the system performance.

The reformatting method is classified into a full formatting through certification and a simple formatting by which the SDL is transferred to the G_2-list of the PDL without certification process in order to reduce the formatting time. The P-list remains unchanged after the completion of the formatting but defective blocks of the SDL are stored as defective sectors in the G2-list. Thus, the G2-list may include defective sectors as well as normal sectors. Nevertheless, the normal sectors is considered as defect sectors.

The full formatting, shown in Fig. 5A, reads the old DMA information and certifies all data area other than the defect sectors registered in the P-list of the old PDL. Rather, the P-list of the old PDL is converted to the P-list of the new PDL without any change. Furthermore, a full formatting disposes of the G_1-list and G_2-list of the old PDL as well as the old SDL and then registers defect sectors found during the certification in the G_1-list of the new PDL.

In contrast, the simple formatting, shown in Fig. 5B, converts the SDL to the G_2-list without certification. Namely, the old DMA information is read and sectors in the P-list, G_1-list and G_2-list of the old PDL are converted to the P-list, G_1-list and G_2-list of a new PDL. Also, after converting the

old SDL entries to sixteen PDL entries, the converted SDL entries are disposed and the new PDL entries are registered in the G_2-list of the new PDL.

Upon execution of a reformatting, the supplementary spare area is considered to be non-existent by the file system because the defect information of the SDL has been moved to the PDL. However, the location information of the supplementary spare area is maintained without change in the SDL block. Thus, an assignment of the supplementary spare area is still considered to be existent by the driver, namely the physical driver. Because the file system recognizes whether a formatting has been executed while the driver cannot, the file system and the driver have inconsistent information regarding the supplementary spare area. Accordingly, different judgements between the file system and driver regarding the supplementary spare area may cause problems in the system control.

Furthermore, a compatibility problem occurs when an optical recording medium as described above is transferred to other drivers. Specifically, when the optical recording medium is inserted into other driver, the driver first reads the DMA from the optical recording medium and informs the file system Then, the file system constructs a new file system using the

information delivered from the driver. At this time, since the location information of the supplementary spare area is still recorded in the SDL block of the DMA, the location information is also sent to the file system together with the information from the driver. Accordingly, the file system regards that the supplementary spare area has been assigned. As a result, the area registered in the SDL block is considered to be actual supplementary spare area and is excluded when assigning the supplementary spare area or when executing linear replacement, thereby producing problems in compatibility.

SUMMARY OF THE INVENTION

Accordingly, an object of the present invention is to solve at least the problems and disadvantages of the related art.

An object of the present invention is to provide an optical recording medium in which the location information of a supplementary spare area registered in the DMA is reset after a formatting the optical recording medium.

Another object of the present invention is to provide a method of formatting an optical recording medium, which resets the location information of a supplementary spare area registered in the DMA when the optical recording medium is

formatted.

Additional advantages, objects, and features of the invention will be set forth in part in the description which follows and in part will become apparent to those having ordinary skill in the art upon examination of the following or may be learned from practice of the invention. The objects and advantages of the invention may be realized and attained as particularly pointed out in the appended claims.

To achieve the objects and in accordance with the purposes of the invention, as embodied and broadly described herein, a method of formatting an optical recording medium includes resetting the location information of the supplementary spare area and converting the assigned supplementary spare area to a writable area. In the present invention, the location information of the supplementary spare area is stored in a specific area of the optical recording medium. In the preferred embodiment, the location information of the supplementary spare area is stored in the SDL of the DMA.

BRIEF DESCRIPTION OF THE ATTACHED DRAWINGS

The invention will be described in detail with reference to the following drawings in which like reference numerals

refer to like elements wherein:

Fig. 1 shows a structure of a general optical recording medium in the related art;

Fig. 2A shows a slipping replacement algorithm in the related art;

Fig. 2B shows a linear replacement algorithm in the related art;

Fig. 3 shows when a spare area is assigned at the top of the data area;

Figs. 4A and B show assigning and expanding supplementary spare area in a disc with a primary spare area as shown in Fig. 3;

Fig. 5A shows an example of a full formatting with certification;

Fig. 5B shows an example of a simple formatting without certification; and

Fig. 6 a flow diagram showing a method of formatting the optical recording medium according to the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings.

Generally, the present invention resets the location information of the supplementary spare area registered in the SDL block when an optical recording medium is formatted. Thus, the judgments of the file system and the driver would match with respect to the supplementary spare area. Fig. 6 is a flow diagram showing the operation of a driver when formatting the optical recording medium according to the present invention.

Referring to Fig. 6, upon receiving a formatting command (step 601), a judgement is made if a supplementary spare area has been assigned (step 602). If the supplementary spare area exists, the location information of the supplementary spare area recorded in the DMA is reset (step 603). To reset the location information of the supplementary spare area, any one of a variety of methods may be utilized. In one example, all the location information values of the supplementary spare area may be converted to the lowest value (for example, 00h) or the highest value (for example, FFh). In another example, the location information may be converted into a specific code value according to a predetermined agreement. That is, the location information value may converted to a value which would allow the file system to recognize that the location information of the supplementary spare area has been reset when the file system receives the DMA information from the

driver.

After resetting the location information of the supplementary spare area in step 603 or if a supplementary spare area has not been assigned as determined in step 602, a judgement is made whether the formatting is with certification (step 604). If the formatting is with certification, all sectors, including the sectors registered in the PDL and the SDL, is certified as shown in Fig. 5A (step 605). Thus, sectors judged to have defects are registered in the new PDL. On the other hand, if the formatting is judged to be without certification, all sectors registered in the SDL is registered in the new PDL without change as shown in Fig. 5B (step 606).

Upon completion of formatting as described above, the sectors of the supplementary spare area equivalent the defective sectors registered on the new PDL slips into and becomes a part of the user area to maintain the initial data recording capacity. At this time, recognizing that a formatting has been performed, the file system disposes the information of the supplementary spare area. Accordingly, the information of the supplementary spare area is disposed from both the driver and the file system after a formatting.

In the above embodiment, the location information of the supplementary spare area is reset prior to the formatting when

a formatting command is input. However, the location information of the supplementary spare area may be reset after the formatting. In such case, steps 604 ~ 606 would proceed prior to steps 602 ~ 603 when a formatting command is received in step 601.

Thus, according to the optical recording medium and method of formatting the optical recording medium in present invention, the location information of the supplementary spare area registered in the DMA is reset when the optical recording medium is formatted. This allows the judgements of the file system and the driver regarding the supplementary spare area to match, thereby leading to a consistent system control and maintenance of compatibility when the optical recording medium is transferred to different drivers.

The foregoing embodiments are merely exemplary and are not to be construed as limiting the present invention. The present teachings can be readily applied to other types of apparatuses. The description of the present invention is intended to be illustrative, and not to limit the scope of the claims. Many alternatives, modifications, and variations will be apparent to those skilled in the art.